CLAIMS

1. A laser array architecture, comprising:

an array of laser fiber amplifiers;

a master oscillator generating a pump beam at a frequency ω_1;

means for coupling the pump beam into each of the laser fiber amplifiers;

means for generating a secondary beam at a frequency ω_2;

an array of optical parametric amplifiers;

means for coupling amplified pump beams from the laser fiber amplifiers into respective optical parametric amplifiers;

means for coupling the secondary beam into each of the optical parametric amplifiers, wherein the optical parametric amplifiers generate an array of high power output sub-beams having a signal frequency ω_s that is the difference between frequencies ω_1 and ω_2;

means for detecting phase differences in the output sub-beams; and

a plurality of phase modulators for adjusting the phases of the laser amplifier input beams in response to the detected phase differences, resulting in phase coherency among the output sub-beams;

wherein the frequency ω_2 is selected to provide a desired output signal frequency ω_s.

2. A laser array architecture as defined in claim 1, wherein:

the optical parametric amplifiers are nonlinear crystals.

3. A laser array architecture as defined in claim 1, wherein:

the means for generating the secondary beam includes a second master oscillator operating at frequency ω_2; and

the plurality of phase modulators are connected to control the phases of the pump beams input to the laser fiber amplifiers.

4. A laser array architecture as defined in claim 1, wherein the means for detecting phase differences comprises:

optical splitting means for obtaining a sample of each of the output sub-beams;

a frequency shifting device connected to vary the frequency of a selected one of the output sub-beam samples; and

a multi-element detector array, each element of which records the result of interfering one of the sub-beam samples with the selected frequency-shifted sample, and generates a phase difference signal;

wherein the selected output sub-beam is used as phase reference and the other sub-beams are adjusted to be phase coherent with the selected sub-beam.

5. A laser array architecture as defined in claim 1, wherein:

the master oscillator generates an output at a frequency ω_s;

the architecture further comprises a frequency doubler coupled to the master oscillator, for generating an output pump beam at a frequency $2\omega_s$;

the secondary beam is derived from the master oscillator at a frequency ω_s;

each of the output sub-beams has a difference frequency of $2\omega_s - \omega_s = \omega_s$ and the optical parametric amplifiers operate in a degenerate mode; and

the plurality of phase modulators include a first plurality of phase modulators connected in the pump beam inputs to the laser amplifiers and a second plurality of phase modulators connected in the secondary inputs to the laser amplifiers.

6. A laser amplifier architecture as defined in claim 5, wherein:

the means for coupling the pump beam to each of the laser fiber amplifiers includes common amplifier and an optical splitter.

7. A laser amplifier architecture a defined in claim 6, wherein:

the means for coupling the secondary beam into the optical parametric amplifiers includes a common amplifier and an optical splitter, wherein the pump beams and the secondary beams are both input to the respective laser fiber amplifiers.

8. A laser amplifier architecture as defined in claim 5, wherein the means for detecting phase differences in the output sub-beams comprises:

optical splitting means for obtaining a sample of each of the output sub-beams;

means for splitting off a reference beam from master oscillator beam;

a frequency shifting device connected to vary the frequency of the reference beam; and

a multi-element detector array, each element of which records the result of interfering one of the sub-beam samples with the frequency-shifted reference beam, and generates a phase difference signal;

wherein the sub-beams are adjusted to be phase coherent with the reference beam.

9. A laser amplifier architecture as defined in claim 1, wherein:

the laser fiber amplifiers have dual doped fiber cores that permit operation in two gain bandwidth ranges simultaneously; and

the frequencies ω_1 and ω_2 are selected to fall within the two respective gain bandwidths of the fibers.

10. A laser amplifier architecture as defined in claim 10, wherein:

the cores of the laser fiber amplifiers include ytterbium (Yb) and erbium (Er) as dopants;

the frequencies ω_1 and ω_2 correspond to wavelengths of approximately 1 μm and 1.5 μm, respectively; and

the outputs of the architecture have a difference frequency of ω_1 - ω_2 corresponding to a wavelength between 3 μm and 4 μm.

11. A method for generating, from an array of laser fiber amplifiers, a high power coherent output beam at a desired wavelength the method comprising the steps of:

generating in a master oscillator a pump beam at a frequency ω_1;

coupling the pump beam to each of element of the array of fiber amplifiers;

generating a secondary beam at a frequency ω_2;

coupling the amplified pump beam from the array of fiber amplifiers into corresponding elements of an array of optical parametric amplifiers;

coupling the secondary beam into each element of the array of optical parametric amplifiers;

generating in each element of the array of optical parametric amplifiers a frequency difference beam having a frequency ω_s that is the difference between the frequencies ω_1 and ω_2, to provide an array of output sub-beams;

detecting phase differences in the output sub-beams; and

adjusting the phases of the laser amplifier input beams in response to the detected phase differences;

wherein the frequency ω_2 is selected to provide a desired output signal frequency ω_s.

12. A method as defined in claim 11, wherein:

the step of generating the secondary beam is performed in a second master oscillator operating at frequency ω_2; and

the step of adjusting phases is effected by phase modulators connected to control the phases of the pump beams input to the laser fiber amplifiers.

13. A method as defined in claim 11, wherein the step of detecting phase differences comprises:

splitting off a sample of each of the output sub-beams;

frequency shifting a selected one of the output sub-beam samples; and

interfering each one of the sub-beam samples with the selected frequency-shifted sample in a detector array, to generate a phase difference signal;

wherein the selected output sub-beam is used as phase reference and the other sub-beams are adjusted to be phase coherent with the selected sub-beam.

14. A method as defined in claim 11, wherein:

the master oscillator for generating the pump beam provides an output at a frequency ω_s;

the method further comprises the step of doubling the master oscillator output, to provide a pump beam at a frequency $2\omega_s$;

the step of generating the secondary beam includes deriving the secondary beam from the master oscillator at a frequency ω_s;

each of the output sub-beams has a difference frequency of $2\omega_s - \omega_s = \omega_s$ and the optical parametric amplifiers operate in a degenerate mode; and

the step of adjusting phases is effected by a first plurality of phase modulators connected in the pump beam inputs to the laser amplifiers and a second plurality of phase modulators connected in the secondary inputs to the laser amplifiers.

15. A method as defined in claim 14, wherein:

the step of coupling the pump beam to each of the laser fiber amplifiers includes amplifying the pump beam in a common amplifier and splitting the amplified pump beam in an optical splitter.

16. A method as defined in claim 15, wherein:

the step of coupling the secondary beam into the optical parametric amplifiers includes amplifying the secondary beam in a common amplifier and splitting the amplified secondary beam in an optical splitter, wherein the pump

beams and the secondary beams are both input to the respective laser fiber amplifiers.

17. A method as defined in claim 14, wherein the step of detecting phase differences in the output sub-beams comprises:

splitting off a sample of each of the output sub-beams;

splitting off a reference beam from master oscillator beam;

varying the frequency of the reference beam; and

interfering each of the sub-beam samples with the frequency-shifted reference beam, in a multi-element detector array, each element of which records detects a phase difference and generates a phase difference signal;

wherein the sub-beams are adjusted to be phase coherent with the reference beam.

18. A method as defined in claim 11, wherein the method further comprises:

selecting the laser fiber amplifiers to have dual doped fiber cores that permit operation in two gain bandwidth ranges simultaneously; and

selecting the frequencies ω_1 and ω_2 to fall within the two respective gain bandwidths of the fibers.

19. A method as defined as defined in claim 18, wherein:

the step of selecting the laser fiber amplifiers selects fibers with cores that include ytterbium (Yb) and erbium (Er) as dopants;

the step of selecting the frequencies provides that frequencies ω_1 and ω_2 correspond to wavelengths of approximately 1 μm and 1.5 μm, respectively; and

the sub-beams provide outputs at a difference frequency of (ω_1 - ω_2), corresponding to a wavelength between 3 μm and 4 μm.